The contribution of citizen rescuers to survival after out-of-hospital cardiac arrest

Valorisation

In industrialised countries sudden out-of-hospital circulatory arrest (OHCA) is an important public health problem[1, 2] largely caused by cardiac disease.[3] Reported survival rates are low (<10%)[4, 5] and have not improved significantly in many countries over the last 30 years.[6] In this thesis we showed that the community responder system in the Netherlands is effective in increasing survival to hospital discharge in OHCA victims, that the degree of disability or dependence after survival is low (chapter 2) and that the contribution of the system to survival is most substantial in cases of witnessed arrest, in the home situation, at slightly delayed arrival of the first ambulance and during the evening/night (chapter 3). The majority of cases involving community responders had a cardiac cause and around 60% of the cases did not have a cardiovascular history. This implies a good prognosis after successful resuscitation and is referred to as patients with "hearts too good to die". It underscores the benefit of deploying community responders in programs to improve survival after OHCA (chapter 4). We also showed that the burden for community responders can be reduced because notification still carries a 50% chance of resuscitation not being required. It is suggested that the effectiveness of the system could be further improved with a higher volunteer density (chapter 5).

Number of lives to be saved

The chapters of this thesis provide information allowing to estimate the number of lives potentially being saved by the system. As outlined in chapter 2, 422 cases with a (presumed) cardiac arrest were included in the two study years (mean 211/year). In case of notification of the system but without citizen rescuers attending survival was 16% (34). In contrast, 27% of OHCA victims (57) survived if at least one rescuer attended. This implies that, due to attendance of citizen rescuers, 23 more (57-34) OHCA victims can be saved yearly in the province of Limburg. When extrapolated, based on about 17 million Dutch inhabitants, nationwide 349 (23*17/1.12) extra patients can be saved due to attendance of citizen rescuers.

This number is in accordance with estimations using data as reported by the Dutch Heart Foundation[7]: the incidence of (presumed) cardiac resuscitations, EMS witnessed cardiac arrests excluded, is 37 per 100.000 per inhabitants per year. Assuming the Netherlands has around 17 million inhabitants, this accounts for 6290 (170*37) resuscitations per year of which reportedly 23% survive[7] (1447). In our study we showed that the citizen rescue system was activated in half of all the cardiac arrests meaning that the system potentially could be activated in 3145 (6290/2) cardiac arrests per year nationwide. If the system is activated but no citizen rescuers attend the resuscitation 503 (0.16*3145) cardiac arrest victims will survive in contrast to 849 (0.27*3145) surviving if at least one rescuer attends. The attendance of citizen rescuers can therefore lead to 346 additional survivors nationwide which is in line with the previous mentioned extra survivors (349) based on our own data.

Therefore, a relative increase in survival by 24% (346/1447) can be achieved if the response rate of citizen rescuers would be optimal (100%). In our study, citizen rescuers responded in 67% of the 3145 notifications, which implies that survival gain could be achieved in 2107 cases. Activation of the system with no responders would lead to 337 (0.16*2107) survivors compared to 568 (0.27*2107) in case at least one rescuer attends the resuscitation resulting in 231 extra survivors nationwide. Therefore, in the current circumstances activation of the system could lead to 16% (231/1447) extra survival.

Opportunities for improvement

Volunteer density and survival

Based on our results on survival related to volunteer density per community it is tempting to speculate about the survival benefit that can be achieved when more volunteers will participate. As suggested in chapter 5, survival rate increased with higher volunteer density. A volunteer density of 7.5 or more volunteers per 1000 inhabitants corresponds with a survival rate of 34.8% if at least one citizen rescuer attends the site of the cardiac arrest. Based on this estimate, 73 of the 211 OHCA cases per year would survive compared to 33 OHCA victims (16%) if no citizen rescuers attend the resuscitation. Attendance of volunteers in communities with a volunteer density 7.5 or more volunteers per 1000 inhabitants results therefore in 40 (73 - 33) more survivors per year in the province of Limburg and 607 (40*17/1.12) nationwide. The observed increase in survival in communities with higher volunteer density can be explained by increased probability of rescuers being near the victim. Ideally, in every street of a neighbourhood rescuers should be available to help their neighbour to survive in case of a cardiac arrest.

Increase of attendance of citizen rescuers

Higher volunteer density is also likely to contribute to an increase in response rate of citizen rescuers. In our study it was found that in about one third of the system activations by the dispatcher no citizen rescuer attended. According to information from the rescuers management organization HartslagNu the number of rescuers is currently estimated to be 12.1 per 1000 inhabitants at the present time. Therefore it is likely that the attendance rate has increased with an expectedly concomitant increase in survival.

The venue of a GPS based notification system

During the study period a zip code based notification system was used. Where the system was static and bound to zip codes and time slots entered by citizens, in the meantime a dynamic system was developed based on the Global Positioning System. This implies that citizen rescuers are no longer bound to places (zip codes) but can be notified everywhere, close to the victim of a cardiac arrest. Clearly, continuous nationwide registries are needed to study the effectiveness of this and earlier mentioned improvements of the system.

Other possible fall outs related to the implementation of the rescuer system

The introduction of the citizen rescuer system and its positive effects on outcomes have likely resulted in more awareness of OHCA in the general population. As a result possibly more cardiac arrests are recognised with early resuscitation attempts started by the witness(es) and earlier notification of the rescue services such as the EMS and the citizen rescue system. Possibly also more citizens are willing to obtain resuscitation skills and local and central governments are more likely to support CPR programs due to increased awareness. In this regard hopefully the Kids Saves Lives concept of the World Health Organisation, advocating CPR teaching programs in school will receive increasing attention.[8]

The development and national implementation of the citizen rescue system has led to an increase in public awareness about OHCA. Many citizens desire to contribute to society and a system such as the community responder system seems to allow them to do so. Moreover organising and maintaining the system within residencies may lead to more interaction and cohesion between citizens, likely contributing to improved quality of life within the communities. As such it fits well within the Healthy Cities concept of the World Health Organisation.[9]

References

1. de Vreede-Swagemakers JJ, Gorgels AP, Dubois-Arbouw WI, et al. Out-of-hospital cardiac arrest in the 1990's: a population-based study in the Maastricht area on incidence, characteristics and survival. J Am Coll Cardiol. 1997;30:1500-5.
2. Berdowski J, Berg RA, Tijssen JG and Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: Systematic review of 67 prospective studies. Resuscitation. 2010;81:1479-87.
3. Zipes DP and Wellens HJ. Sudden cardiac death. Circulation. 1998;98:2334-51.
4. Waalewijn RA, de Vos R and Koster RW. Out-of-hospital cardiac arrests in Amsterdam and its surrounding areas: results from the Amsterdam resuscitation study (ARREST) in 'Utstein' style. Resuscitation. 1998;38:157-67.
5. Hasselqvist-Ax I, Riva G, Herlitz J, et al. Early cardiopulmonary resuscitation in out-of-hospital cardiac arrest. N Engl J Med. 2015;372:2307-15.
6. Sasson C, Rogers MA, Dahl J and Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes. 2010;3:63-81.
7. Zijlstra JA, Radstok A, Pijls R, et al. Overleving na een reanimatie buiten het ziekenhuis: vergelijking van de resultaten van 6 verschillende Nederlandse regios *Reanimatie in Nederland, 2016* Den Haag Nederlandse Hartstichting 2016.
8. Bottiger BW, Semeraro F and Wingen S. "Kids Save Lives": Educating Schoolchildren in Cardiopulmonary Resuscitation Is a Civic Duty That Needs Support for Implementation. J Am Heart Assoc. 2017;6.
9. Green G, Jackisch J and Zamaro G. Healthy cities as catalysts for caring and supportive environments. Health Promot Int. 2015;30 Suppl 1:i99-i107.